Multipolarity Effects of Growth Centers Between Kalimantan and Other Major Islands in Indonesia:

Can it Diminish Inter-Island Disparity?

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Abstract

Kalimantan, well known as Borneo, the third biggest island in the world and one of the Indonesian Economic Corridors, has been designed by the Indonesian Government as the national energy source. This decision is that Kalimantan has the abundant mining resources and the vast coverage of tropical rainforests. Therefore, Kalimantan serves as the world's lung. Unfortunately, these abundant natural resources do not diminish the disparity found between Kalimantan as the Indonesian Economic Corridor and other major islands in Indonesia. This disparity even tends to increase. Why does this condition happen?. It is assumed that the interaction among growth centers eventually leads to backwash effect on growth centers in Kalimantan.

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This paper aims at examining multipolarity effect between growth centers in Kalimantan and other major islands by using Spatio-Temporal analysis. It focuses on the flows of goods and passenger for two time periods. Time and distance factors are used to examine multipolarity among growth centers. The polarization of goods flow from growth centers in other major islands in Indonesia to Kalimantan tends to be faster. On the contrary, the polarization of goods flow from growth centers in Kalimantan to the other major islands tends to be slower.

Keyword: Growth Centers; Multipolarity; Spatio-Temporal; Kalimantan.

1.   Introduction

The process of economic growth in an area has a significant correlation with its geographical site. The hypothesis on polarization effect on the spread of economic growth proposed by Hirschman provides beneficial contribution for the development of regional economic study. It attempts to explore the influence of the growth spread from economic and spatial aspects [5]. Spatial polarization of economic growth can be identified from the operationalisation of growth poles or growth center as Perroux has explained. Growth centers or growth poles are defined as an area or urban center with longer growing experience and has positive effects for the growth of the hinterlands [7].

The polarization of growth center does not only depend on certain areas but also the hinterlands. It means that the intensity of economic growth is the function of time and distance, and it involves the economic growth of growth centers and their hinterlands [3]. An intensive interaction between growth centers and their hinterlands eventually results in the development of those areas. It is expected that the strategies provide a positive polarization effect [1]. Thus, this condition becomes the important reference for spatial planners in formulating strategies to strengthen growth centers.

Some researchers have conducted a study on the polarization effect on the hinterlands due to the existence of growth centers. The polarization effect on some growth centers in Mid Western proves the influence of distance between the hinterlands and growth centers. Some growth centers in major cities give the positive effects of the increase of retail trade in small cities during the period of 1945-1967. The process of economic growth in small cities results in dependency, and it transforms big cities as the center of economic activities [2].

In June 2011, World Bank examined the trans-nation growth polarization and concluded that growth centers triggers global growth as the result of economic polarities, trade, financial, migration, and technology spillover [6]. The various effects of polarization growth are explored through empirical investigation on the population growth for small urban centers in Midwestern. The result shows negative correlation between population growth and distance from major population growth [4]. This study concludes that the growth of urban centers depends on some simultaneous effects such as the coverage of the areas and the local effect of neighbour cities.

The disparity of the economic growth in major islands in Indonesia remains as the most important problem. Java Island is more dominant in investment sector as its prime economic activity than other islands such as Sumatera, Kalimantan, Bali+Nusa Tenggara, Sulawesi and Maluku+Papua. One essential strategy to overcome this problem is by establishing growth centers in Indonesia. These growth centers have been developed since the

establishment of *Integrated Economic Development Areas (KAPET)* in 1996 and *Indonesia Economic Corridor* in 2010. The polarization of economic growth among major island is expected to occur soon. However, the disparity among the major islands in Indonesia still exists because the connectivity among growth centers has not run smoothly [8].

Kalimantan, well known as Borneo, has rich natural resources such as mining and the biggest coal production in Indonesia. The output contribution of agricultural sector and mining excavation subsector is far exceeded national output. Unfortunately, the abundant natural resources are not enough for Kalimantan to compete with the advances of the other islands such as Java and Sumatra. Does this condition result from multipolarity among growth centers, which tends to bring negative result?. This paper aims at examining the multipolarity effect among growth centers in Kalimantan and other major islands in Indonesia by using Spatio-Temporal analysis of the flows of goods and passengers in 2006 and 2011. The initial detection on the polarization effects of growth centers in Indonesia is so important to give a suitable solution for the disparity among major islands in Indonesia that still happens until now. However, this research has not yet identified the location of the growth centers for each province in Kalimantan which have the biggest polarization effect either towards the flows of goods or the flows of passengers.

2.   Material and methods

2.1.   Literature review

Some previous studies focus on the examination and the measurement of spatial polarization particularly on growth center and among nations. The existence of growth centers and the effect they cause still becomes the source of argument in the literature of regional development study.

Casseti, King and Orland [2] examined spatial polarization for the retail trade cases in Midwestern during 1948-1967. They examined the effect of the distance between growth centers and the trade rate. Growth centers are classified into 8 classes based on the population size. A positive polarization on growth will occur if partial derivation z serves as the function from (x, y, t) towards distance (s), and time interaction (t) is smaller than 0 ($\delta z^2/\delta s \delta t < 0$). On the other hand, a negative polarization of growth centers will occur if the value is more than zero ($\delta z^2/\delta s \delta t > 0$). This research only focuses on distance as the factor although the growth of urban centers undoubtedly varies due to other factors. The result of the research shows that the growth pattern in Midwestern depends on the distance from growth centers. A number of retain trade is getting higher on cities nearer to growth centers with the highest level.

Kane and Lim [6] conducted a research to examine polarization among nations. They performed empirical measurement on growth polarization (P_{it}), exchange polarization (P_{it}^T), financial polarization (P_{it}^{Ft}), migration polarization (P_{it}^m), and technology spillover (P_{it}^A); Second, they determined essential factors for the polarization of growth poles which was estimated by using Dynamic Panel Model to obtain more valid results.; Third, they examined the relationship of growth poles (multipolarization) from time to time by revealing each trend on Herfindah-Hirschman index, Theil index, and Gini coefficient. This research resulted in some concluding

remarks. First, the polarization growth of each measurement is not evenly distributed. In other words, the distribution of economic activity is not proportional. Second, the research shows strong correlation between the quality of the institution and growth polarization. Third, the concentration size shows decreasing tendency, although globalization era requires the more intense relationship of pole multipolarization.

2. 2. *Spatio-temporal model*

A built method aims at examining the polarization of goods and passanger flow in 2006 and 2011. The research locations are 67 growth centers in each major island in Indonesia. Z is spatial-temporal coordinate from x and y with domain S, and t in domain T. S is treated as *Eucledian Distance* of each x, y point in an area towards central area with coordinate x^0, y^0. It means

$$S = [(x - x^0)^z + (y - y^0)^z]^{1/s} \quad (1)$$

It is assumed that z is a function derived towards s and t in any domain with an exception when s=0. The intensity Z in S will increase from time to time if,

$$\partial Z / \partial t > 0 \qquad (2)$$

A positive or negative polarization resulted from growth centers will occur if,

$$\partial^2 Z / \partial S \partial t < 0 \quad \partial^2 Z / \partial S \partial t > 0 \quad (3)$$

A positive polarization occurs when equation (2) shows the result >0 and equation (3) has result <0. It shows that the growth level of Z is inversely proportional towards distance from the central point. On the other hand, a negative polarization occurs if the growth level of Z is directly proportional towards distance from the central point

A formal characteristic of growth in an area is examined by estimating parameter from a function which has derivative not equal to zero towards t and s. The implementation of expansion method will be much easier to produce a suitable function. If it is assumed that function Z is only related to time (t), a linier function of time will be as follows

$$Z(t) = a + bt \quad (4)$$

Expansion method is beneficial to redefine parameters in equation (4) as function from variable s which follows initial model in distance which will be expanded. In this paper, a and b are defined as a linier function from s to produce Z(s,t) which has the second partial derivative unequal to zero. Thus, the function can be defined as follows:

$$a = a_0 + a_1 s \quad (5)$$

$$b = b_0 + b_1 s \quad (6)$$

Then, it is used in equation (4) to produce:

$$Z(s,t) = a_0 + a_1s + b_0t + b_1st \quad (7)$$

Equation (7) is used to test polarization from single center x^0, y^0. The observation on the values of z,t, and s is beneficial to estimate parameter in equation (7). The hypothesis of either positive or negative growth polarization towards x^*, y^* occurs if:

$$\frac{\partial Z}{\partial t} = \bar{b}_0 + \bar{b}_1 S > 0 \; dan \; \frac{\partial^2 Z}{\partial t \partial S} = \bar{b}_1 < 0 \; or \; \frac{\partial^2 Z}{\partial t \partial S} = \bar{b}_1 > 0$$

A simultaneous polarization hypothesis from the number of central points is tested by using similar method. In the previous case, the function is developed from the number of distance variables among central points.

Parameter a and b in equation (4) is developed into a linier function as follows :

$$a = a_0 + a_1s_1 + a_2s_2 + \ldots + a_ns_n \quad (8)$$

$$b = b_0 + b_1s_1 + b_2s_2 + \ldots + b_ns_n \quad (9)$$

A substitution of equation above into equation (4) will result in :

$$Z(s_1, s_2, t) = a_0 + \sum_i^n a_i s_i + b_0t + t\sum_i^n b_i s_i \quad (10)$$

A parameter in equation (10) is estimated by using data consisting of n=2, with t as time intensity and n as growth center. A positive or negative polarization towards n as growth center is verified by examining partial derivative on z estimation, for example, a positive polarization on particular distance (si) can be confirmed if :

$$\frac{\partial^2 z}{\partial t \partial si} = b_i < 0 \quad (11)$$

An estimation performed covers potential growth centers in an area. In this context, the examination of growth centers in Kalimantan does not only include neighbour areas but also between growth centers in Kalimantan and other major islands.

2.3.   The hypothesis test on the effect of distance among growth centers

The distance effect among growth centers (s) is defined as the nearest distance between growth centers in Kalimantan and other major islands. Growth centers are not only located in the capitals of provinces in Indonesia but also all districts/municipalities that have been designed by the government as growth centers. The hypothesis towards the effect of distance is explained as follows:

$$\frac{\partial z}{\partial t} \geq 0$$

A positive growth center causes multipolarity effect for other growth centers when:

$$\frac{\partial^2 Z}{\partial s \partial t} < 0$$

Alternatively, a growth center is unable to empower multipolarity effects on other growth centers when:

$$\frac{\partial^2 z}{\partial s \, \partial t} > 0$$

Spatio-temporal analysis on the goods flows (Z_1) and passenger flows (Z_2) in 2006 and 2011 is divided into two models. First, growth centers in Kalimantan to growth centers other islands in Indonesia (Model 1). Second, growth centers in other islands in Indonesia to growth centers in Kalimantan (Model 2). The growth pattern in a particular area varies which depend other factors. This research focuses on the distance effect among growth centers (S and S^2). Generally, this research explains the polarization between growth centers in Kalimantan and other major islands such as Sumatera, Jawa, Bali+Nusa Tenggara, Sulawesi, and Maluku+Papua.

3.   Results

3.1.   *The Distribution of goods and passangers flows*

More than 35 percent of goods flows from growth centers in Kalimantan go to growth centers in Sulawesi. However, the goods flows in growth centers in Kalimantan comes from Java Island (Figure 1a). The increase of goods flows from Kalimantan to the other major islands is lower than the goods flows from other islands to Kalimantan.
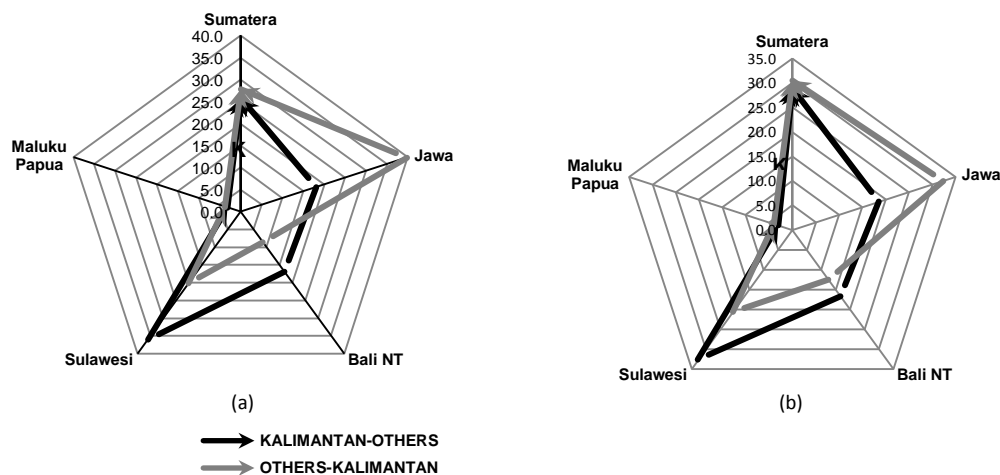

Figure 1. The Percentage of Goods Flows (a) and Passengers Flows (b), 2011

The distribution of passengers flows described in Figure 1b shows that the highest percentage of passenger flows from growth centers in Kalimantan goes to Sulawesi. Other growth centers in major islands particularly

Java contributes to the significant passenger flows in Kalimantan. The passenger flows from growth centers in other major islands to Kalimantan has the relatively higher rate. However, the passenger flows from growth centers outside Kalimantan to growth centers in Kalimantan has relatively higher increase.

3.2.   *Disparity and polarization*

Literature about the polarization continues developing; therefore, it is important to clarify related to the concept and measurement. However, the researcher should understand that the concept of polarization does not fit with the disparity concept. Comparing polarization and disparities among areas, in addition to finding similarities, have some differences. Before conducting the polarization test, this research compares among polarizations by using the Enthrophy Theil Index, which is commonly used to measure disparities among regions. To give a more detailed explanation, Table 1 presents the index of theil and trade polarization for all provinces in Kalimantan in 2 periods, 2006 and 2011. When examining the result, a researcher is able to observe trend differences in polarization and disparity. For example, in 2006, West Kalimantan has the lowest disparity index compared to other provinces in Kalimantan. However, this area has the highest polarization index compared to other three provinces; East Kalimantan, South Kalimantan, and Central Kalimantan. In 2011, West Kalimantan has the lowest Theil index compared Central Kalimantan and East Kalimantan. However, this area has the highest polarization index compared to other provinces in Kalimantan.

Table 1: Theil and Polarization Indexes according to Provinces in Kalimantan, Indonesia

Province	Growth	Theil		Polarity	
		2006	2011	2006	2011
West Kalimantan	1.98481	0.00433	0.00428	0.06966	0.19764
Central Kalimantan	2.03759	0.00470	0.00440	0.02130	0.13219
South Kalimantan	2.01391	0.00434	0.00382	0.03453	0.09026
East Kalimantan	1.80735	0.01635	0.01504	0.03994	0.09266

This research reveals an interesting finding related to the relationship between growth, disparity, and polarization. Figure 2 presents the disperse diagram on the growth level of all provinces in Indonesia (Gross Domestic Regional Product) and the level of polarization and disparity changes..The correlation coefficient between growth level and polarization is 0,803. This research observes a strong positive relationship since provinces having a high growth level also has a higher polarization level. The result shows that the growth process in Indonesia leads to the increase of polarization although it needs a deeper analysis to be inferred as a causal relationship. Similar examination is also conducted for disparity (Theil Index). The result reveals the similar condition in which growth is followed by the increase in disparity; however, the correlation is so low (0,012).). In general, these findings prove that the growth process is accompanied by a larger disparity. Therefore, the growth must be related to polarization. As a result, the statistical examination on the effect of polarization is completely important to solve problem on inter-regional disparity.
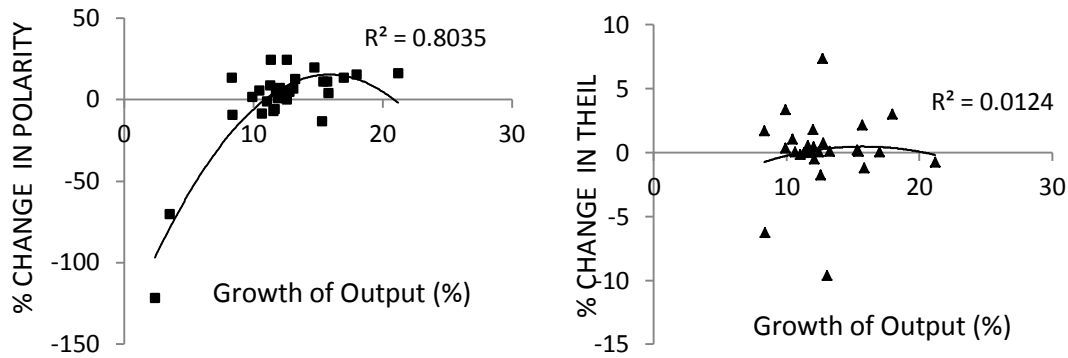
Figure 2: The relationship between Growth and the Changes of Polarization and Theil

3.3. *The polarization of goods flows between growth centers in Kalimantan and other major islands in Indonesia.*

The value of Z_1 of Model 1 and Model 2 is defined for the total goods flows among municipalities/cities in time tn as follows:

$$Z_1 (t_n, s, s^2) = \frac{\text{total of goods flow } (tn, s, s^2)}{\text{total of goods flow } (to, s, s^2)}$$

Z_1 refers to goods flows on time t_0 (2006) and t_n (2011) which represents the behavior of goods flow growth, with the parameter estimation function as follows:

$$Z_1 = a_0 + a_1 s + a_2 s^2 + b_0 t + b_1 st$$

The statistical examination for Model 1 and Model 2 results in following equations:

$$Z_{11} = 44994.947 - 53.107\, s + 0.014\, S^2 + 1532.736\, t - 0.607\, st$$

$$(-9.760)^{**} \quad (8.636)^{**} \quad (1.907)^{*} \quad (-1.015)$$

$$Z_{12} = 38522.648 - 46.544\, s + 0.012 S^2 + 2723.240\, t - 0.820\, st$$

$$(-8.368)^{**} \quad (7.397)^{**} \quad (3.315)^{*} \quad (-1.341)$$

Coefficient significance is given by t in bracket, which identifies that s is different from zero in level α=5% (**) and α=10% (*) either in Model 1 or Model 2. Growth occurs in those areas when,

$$\frac{\partial z_{11}}{\partial t} = 1532.736 - 0.067\ s; \quad \frac{\partial z_{12}}{\partial t} = 2723.240 - 0.820\ s;$$

The first derivative on t for both models results in the value > 0 each for s < 22876,657 and s < 3321,024.

The hypothesis from positive polarization is presented in the second derivation which has a negative value for each model, those are

$$\frac{\partial^2 Z_{11}}{\partial t\,\partial s} = -0{,}067 \text{ and } \frac{\partial^2 Z_{12}}{\partial t\,\partial s} = -0{,}820$$

The result shows that the polarization of goods flow from growth centers in other major islands to Kalimantan tends to be faster than the reverse direction (Figure 3).

The polarization examination on each island results in important findings as follows:

- The polarization of goods flow from growth centers in Kalimantan to Sumatra and goods flow from growth centers in Sumatra to Kalimantan shows a negative polarization. This condition occurs because both areas have similar seed sectors, particularly in important sectors such as plantation, forestry, and oil and gas.

- The polarization of goods flow from growth centers in Java to Kalimantan is faster than from Kalimantan to Java. The polarization of goods flow from Kalimantan to Java and vice versa occurs because both areas have different seed sectors, so they require the exchange of goods. In general, the goods flow from Kalimantan to Java includes raw materials as the result of forestry, plantation, oil and gas. On the other hands, Java sends processed food products and other industries for Kalimantan.

- The polarization of goods flow from growth centers in Bali and Nusa Tenggara to Kalimantan is faster than from Kalimantan to Bali and Nusa Tenggara. The goods flow from Bali and Nusa Tenggara to Kalimantan includes food products and livestock sectors.

- The polarization of goods flow from the growth centers in Kalimantan to Sulawesi is faster than from Sulawesi to Kalimantan. Sulawesi depends on the oil and gas sector and industry which can be obtained only from Kalimantan.

- The polarization of goods flow from the growth centers in Maluku and Papua to Kalimantan is faster than from Kalimantan to Maluku and Papua. Although these islands have the same resources such as forestry and mining sectors, the output of forestry and mining in Papua +Maluku has greater quantity than Kalimantan. In addition, Maluku + Papua also have leading sectors such as food crops which can not be found in Kalimantan.

3.4. *The Polarization of passenger flows between growth centers in Kalimantan and other major islands in Indonesia.*

Similar to the value of Z1, Z2 values in model 1 and model 2 is defined for the total passenger flow between districts and cities at tn time as follows:

$$Z_2 \left(tn,\ s,\ s^2 \right) = \frac{\text{total of passenger flow} \left(tn, s, s^2 \right)}{\text{total of passenger flow (to, s, s}^2)}$$

With the function of parameter estimation is:

$$Z_2 = a_0 + a_1 s + a_2 s^2 + b_0 t + b_1 st + b_2 s^2 t$$

t0 (2006) and tn (2011) refer to time reflects the growth behavior of passenger flow. The statistical test for the model 1, the flow of passengers from the growth centers in Kalimantan to other major islands and vice versa, is represented in Model 2 is as follows:

$$Z_{21} = 14123.81 - 14.911\ s + 0.004\ S^2 + 1827.178\ t - 1.179\ st$$

$$(\ 1.171\ )\ (\ 5.006\ )^{**}\ (\ 4.10\ )^{**}\ (\ -3.555\ )^{**}$$

$$Z_{22} = 12663.469 - 11.445\ s + S2 + 0.003 - 1.135\ 2194.701\ t\ st$$

$$(\ -3.097\ )^{**}\ (\ 2,862\ )^{**}\ (\ 4,021\ )^{**}\ (\ -2.795\ )^{**}$$
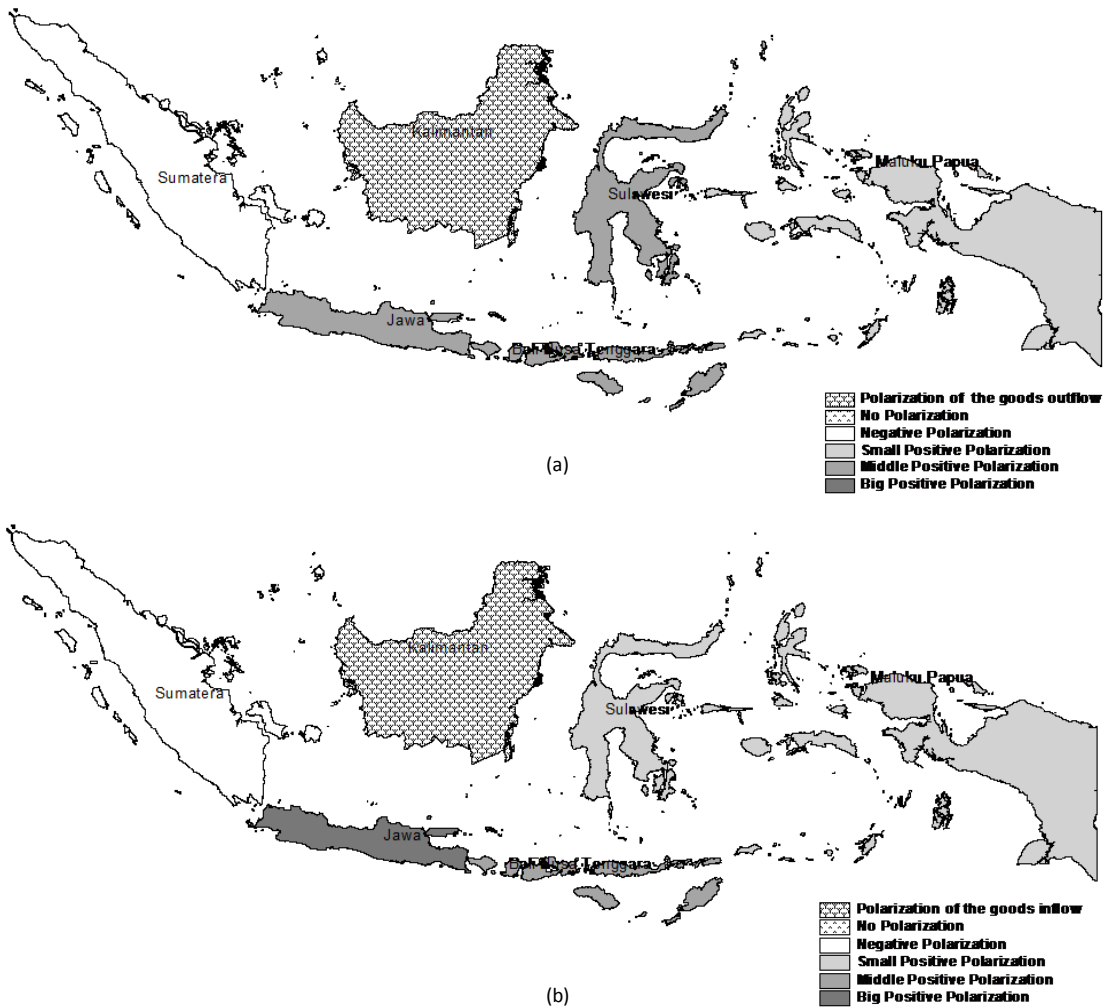

Figure 3: The Result of Multipolarity Test of the good outflow (a) and inflow (b)

The coefficient significance is given by t in parentheses, which indicates that s is not equal to zero at level α = 5% (**) both in model 1 and model 2. Growth occurs when,

$$\frac{\partial z_{21}}{\partial t} = 1827.178 \; \text{-}1.179 \; s; \; \frac{\partial z_{22}}{\partial t} = 2194.701 \; \text{-}1.135 \; s;$$

The first derivative on t for both modes results in the value > 0 each for s < 1549,769 and s < 1933,657.

The hypothesis from positive polarization is presented in the second derivation which has a negative value for each model, those are

$$\frac{\partial^2 z_{21}}{\partial t \, \partial s} = \text{-}1,179 \text{ and } \frac{\partial^2 z_{22}}{\partial t \, \partial s} = -1,135$$

 The result shows that the polarization of passenger flows from growth centers in Kalimantan to other islands tends to be faster than the polarization of passenger flows from other islands to growth centers in Kalimantan (Figure 4).

Partially, polarization examination in each island is as follows:

* Test on polarization of passenger flow between growth centers in Kalimantan and Sumatra shows that the passenger flow from Kalimantan to Sumatra has a positive value. In contrast, the polarization of the passenger flow from growth centers in Sumatra to Kalimantan is negative.

* The polarization of passenger flow growth centers in Kalimantan to Java does not occur, but the passenger flow from the growth centers in Java to growth centers in Kalimantan has negative polarization.

* Polarization of passenger flow of growth centers in Bali Nusa Tenggara to growth centers in Kalimantan has a negative polarization. Unfortunately, there is no polarization of the passenger flow from growth centers in Kalimantan to growth centers in Bali Nusa Tenggara.
* The polarization of passenger flow from growth centers in Sulawesi to Kalimantan is faster than from Kalimantan to Sulawesi.
* The flow of passengers from the growth centers in Kalimantan to Maluku and Papua does not show any polarization. In contrast, the polarization of the passenger flow from Maluku and Papua to Kalimantan has a positive value.

3.5.   *The polarization of goods flow and passengers flow among growth centers in Kalimantan*

A Statistical analysis of goods flow and passenger flow among growth centers in Kalimantan produce equation, respectively:

$$Z_1 = 125158.408 - 462.488 \; S + 0.392 \; S^2 + 2560.116 \; t - 3.263 \; st$$

$$(\text{-}6.651)^{**} \quad (5.840)^{**} \quad (0.779) \quad (\text{-}0.528)$$

$$Z_2 = 29060.490 \; \text{-}156.367 \; S + 0.161 \; S^2 + 7431.764 \; t \; \text{-}10.774 \; st$$

(-4.500)**   (4.800)**   (4.529)**   (-3.488)**

The significance of the coefficient has given by *t* in parentheses, which identifies that *s* not equal to zero at α = 5 % (**). Growth has existed in the region if

$$\frac{\partial z_1}{\partial t} = 2560.116 - 3.263\ s \quad \text{and} \quad \frac{\partial z_2}{\partial t} = 7431.764 - 10.774\ s$$
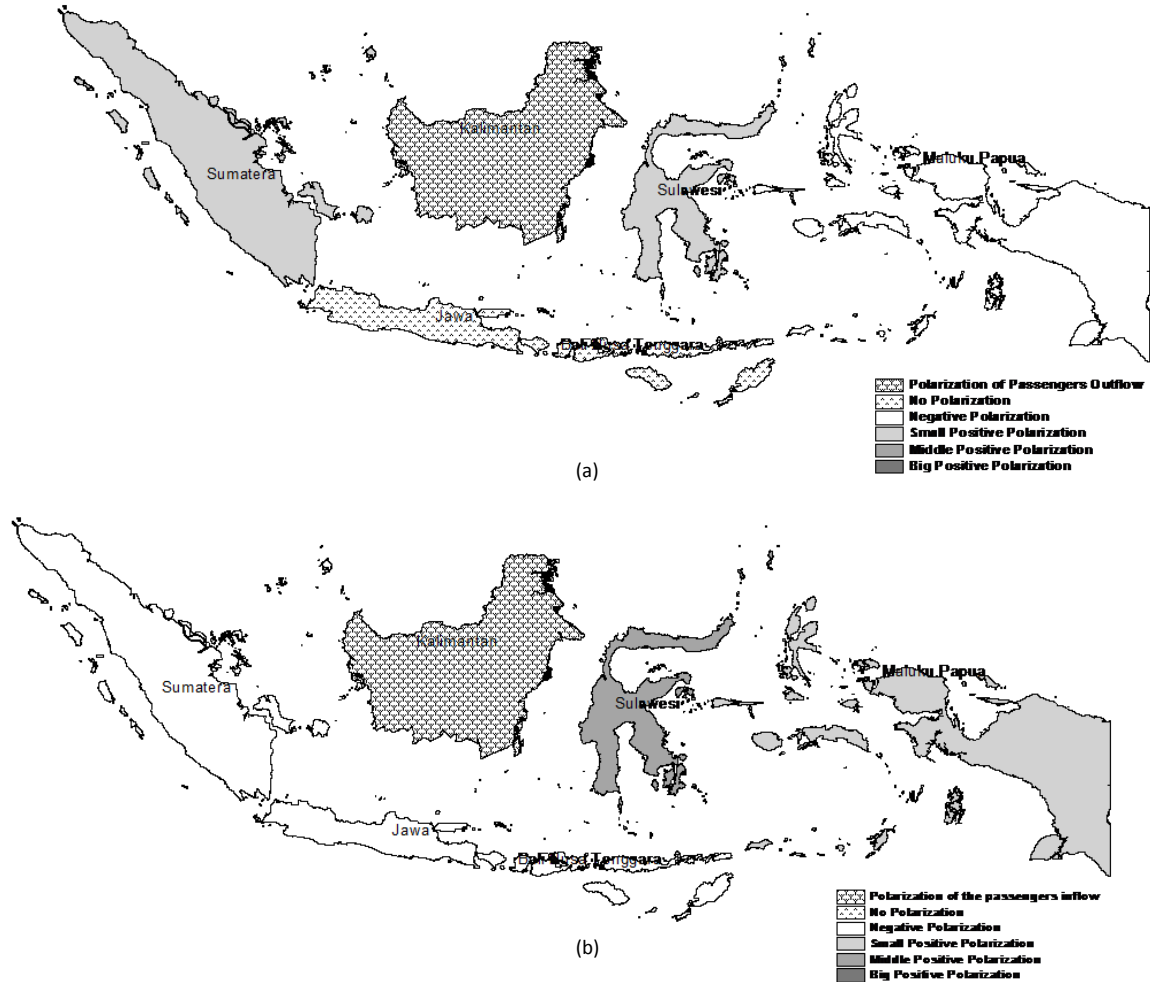

(a)

(b)

Figure 4: The Result of Multipolarity Test of the passengers outflow (a) and inflow (b)

The first derivative of the t in both models produces a value > 0 for s < 0.784 or s < 689.787. The hypothesis of positive polarization are presented in the second derivative which has a negative value in the model

$$\frac{\partial^2 Z_1}{\partial t\, \partial s} = -\ 3.263 \quad \text{and} \quad \frac{\partial^2 Z_2}{\partial t\, \partial s} = -\ 10.774$$

These findings show that the flow of goods and flow of passengers among growth centers in Kalimantan has showed positive polarization. This indicates that the passenger flow polarization among growth centers in Kalimantan faster than the polarization of goods flow.

4.   Discussion

Data on passengers and goods flows have confirmed the polarization among growth centers. However, some major islands do not show the polarization of either passengers or goods flows. Even if polarization occurs, the polarization speed between growth centers in Kalimantan and other major islands is immensely different. Some polarizations have a negative mark.

This finding shows that growth centers in Kalimantan have high demand for goods from other islands. Meanwhile, people living in growth centers in Kalimantan have a tendency to migrate to growth centers in other major islands. This condition becomes the challenge for the regional government to find effective method to empower the society in accelerating the regional development.

Specifically, the polarization of passenger flow among growth centers in Kalimantan has a tendency to be faster compared to the goods flow. This situation reveals that the existence of growth centers in Kalimantan results in a faster migration flow. On the other hands, the polarization of goods flow among growth centers in Kalimantan has a tendency to be slower than in other major island. The result of polarization examination provides the answer of why growth centers are still unable to diminish disparity among islands particularly between Kalimantan and other islands.

5.   Suggestion

In the attempt to overcome problems on disparity among islands particularly between Kalimantan and other islands in Indonesia, one effective method can be undergone by improving the interaction pattern especially the goods flow among growth centers in Kalimantan and other major islands.

The situation results from the existing interaction pattern among growth centers is particularly intended for goods flow, and it is simply based on the advantages obtained local natural resources. In the future, the interaction pattern of goods flow must be based on the competitive ability of local natural resources. Another method is to improve the trade transaction value among growth centers.

The goods flow from Kalimantan must be a diverse product instead of raw-material based products. The development of products obtained from forestry and mining sectors does not only alleviate the output quality but also provide more job opportunities. Those solutions eventually improve the polarization of goods flow from Kalimantan and slower the polarization of passenger flow to other islands in Indonesia.

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